SNAP Presentation

Wednesday – 1 December 1999

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CMB & SN Ia
COSMOLOGY

Science Goals

Testing Cosmological Models

Determining Cosmological Parameters

CMB Program

Steady program of improving observations

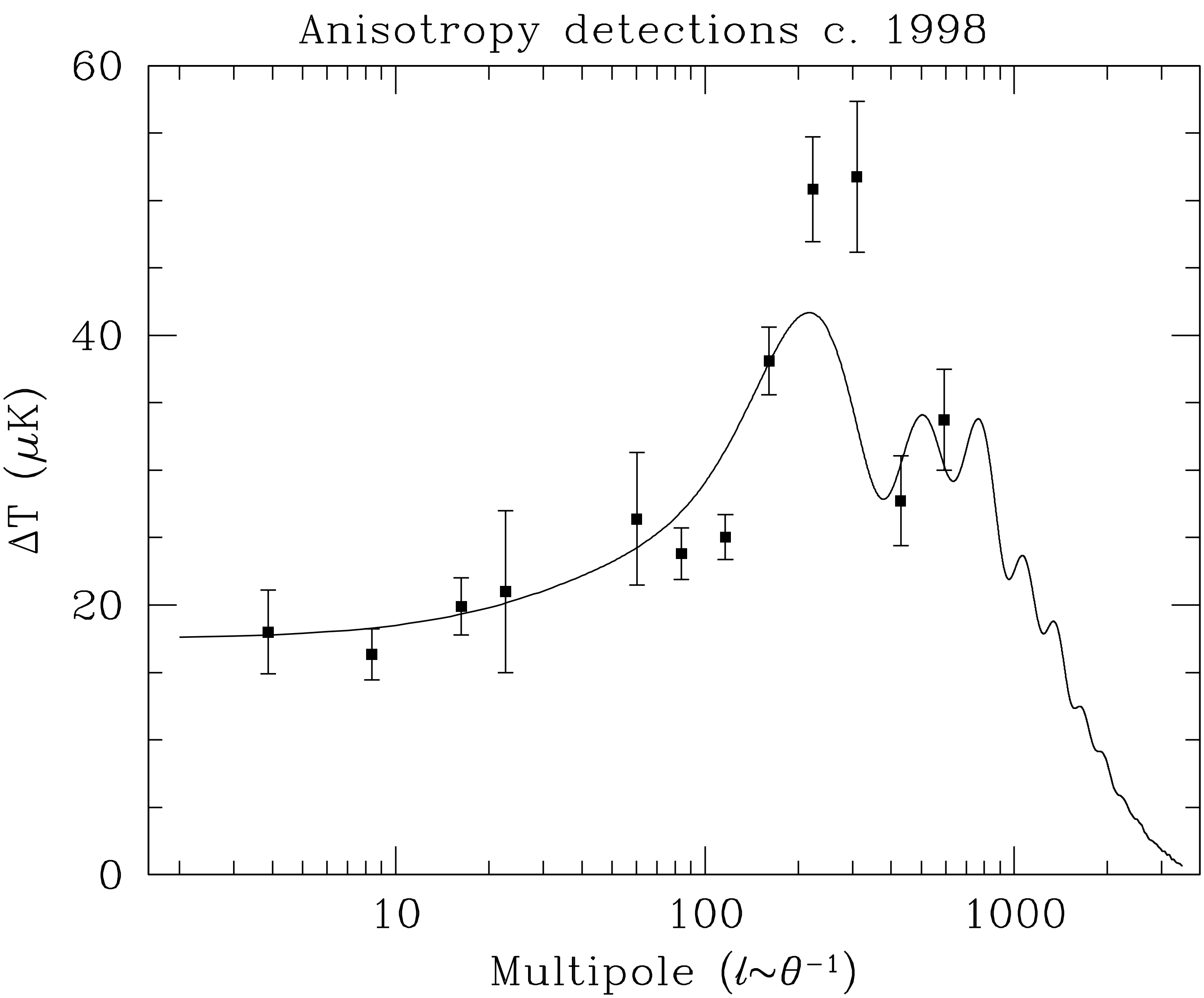
COBE, many ground-based & balloon-borne

Second Generation Experiments

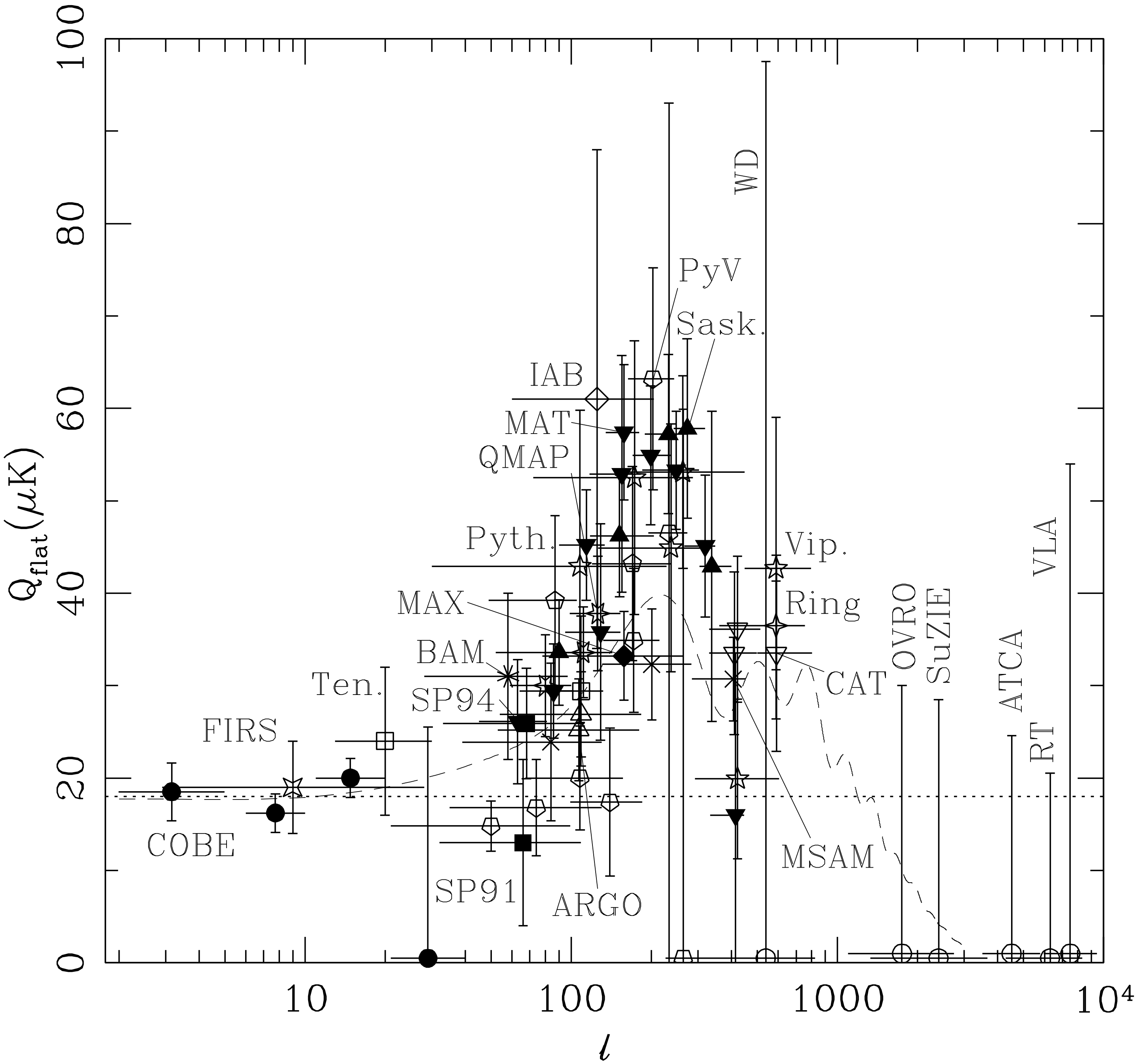
- MAP, Planck = approved new satellites
- MAXIMA/BOOMERANG, TOPHAT,
- interferometers: VSA, CBI, DASI

Represents a steady improvement toward high precision determination of cosmological parameters

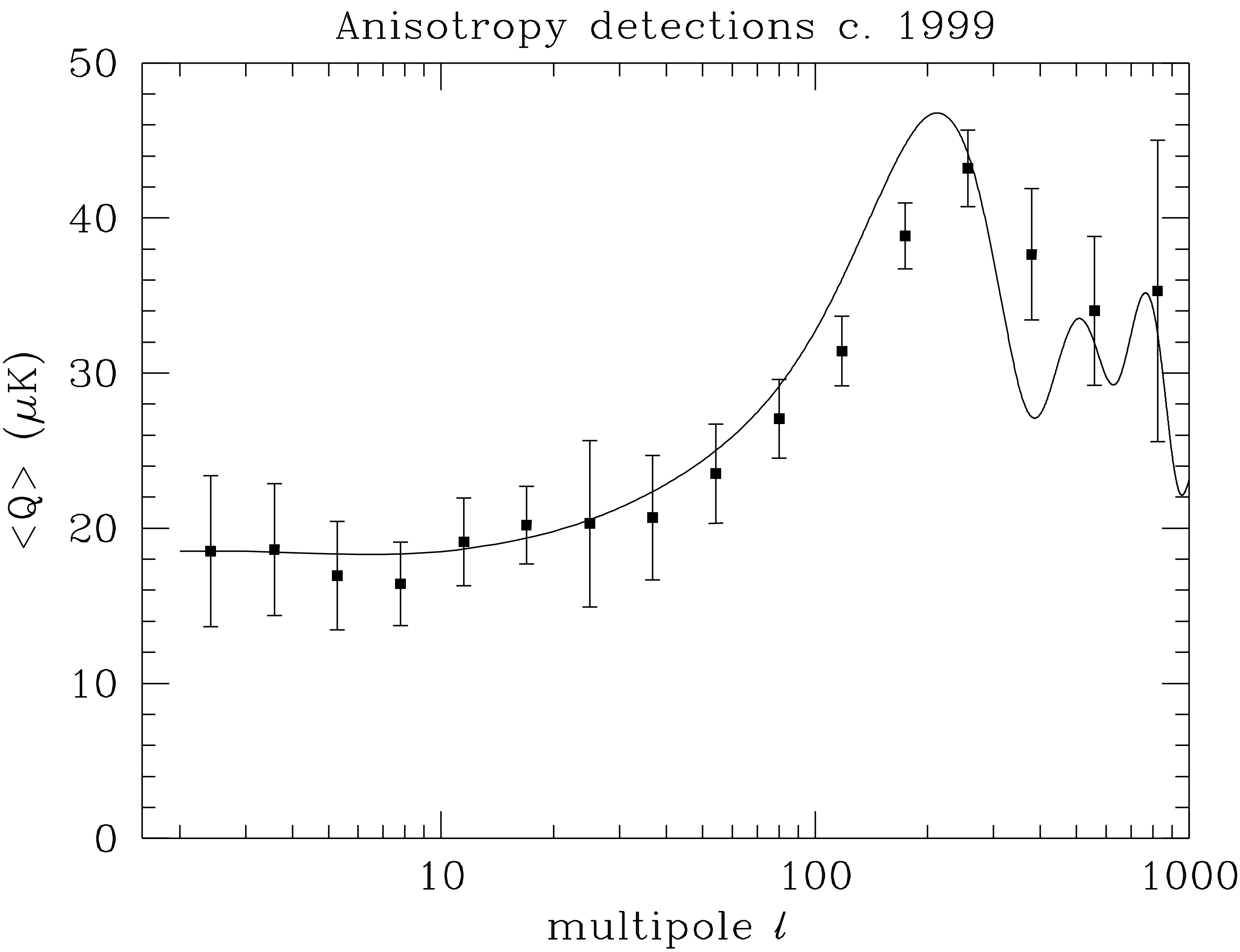
This is a powerful but only one individual approach.



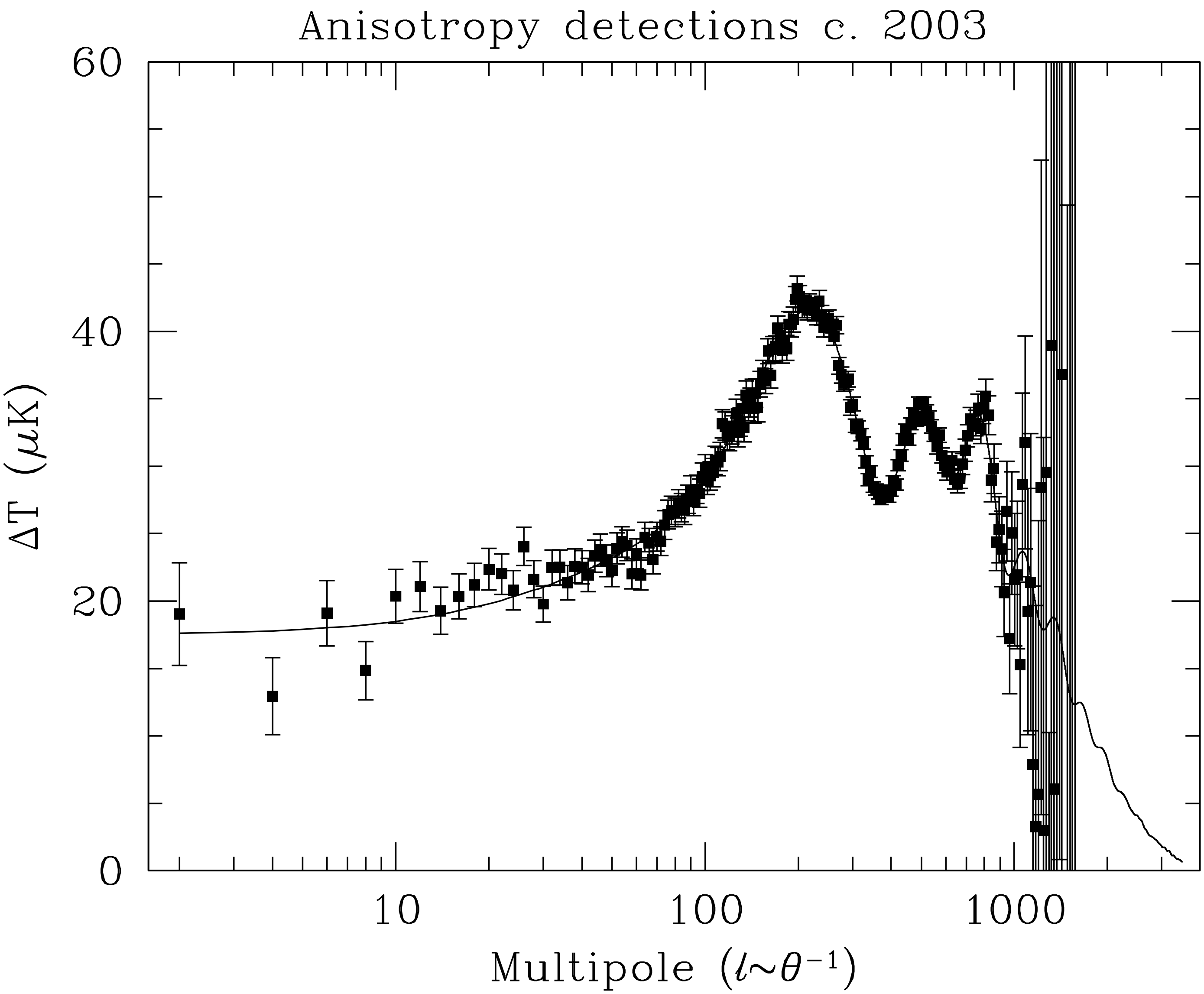
Anisotropy detections c. 1998
0
20
40
60
10
100
1000
ΔT (μK)
Multipole (l~θ⁻¹)

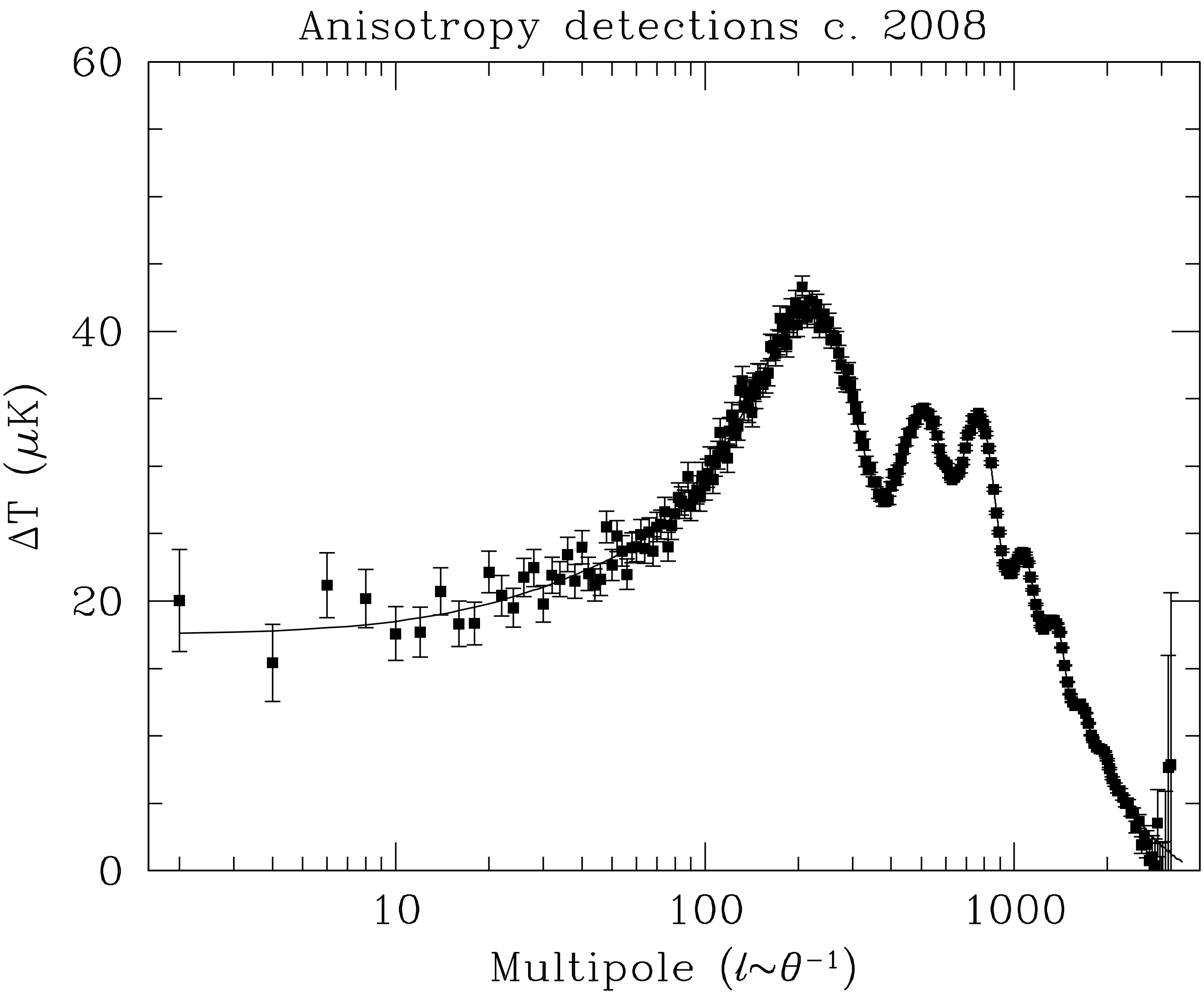


$Q_{flat}(\mu K)$
ℓ
0
20
40
60
80
100
10
100
1000
10^4
COBE
FIRS
Ten.
SP94
SP91
BAM
MAX
Pyth.
QMAP
MAT
IAB
PyV
Sask.
WD
ARGO
MSAM
Vip.
Ring
CAT
OVRO
SuZIE
ATCA
RT
VLA



Anisotropy detections c. 1999
<Q> (μK)
0
10
20
30
40
50
10
100
1000
multipole l


Anisotropy detections c. 2003
60
40
20
0
ΔT (μK)
10
100
1000
Multipole (l~θ⁻¹)



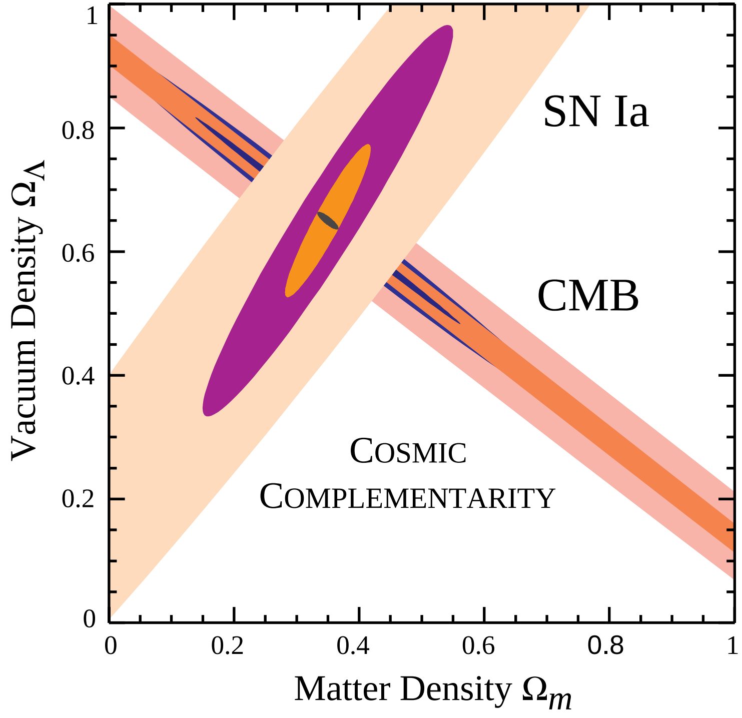
Anisotropy detections c. 2008
60
40
20
0
ΔT (μK)
10
100
1000
Multipole (ℓ~θ⁻¹)

Why doesn't the CMB do the full job?

1. **Results Degeneracy:** There is a "geometrical" degeneracy in CMB results This near degeneracy leaves some parameters with significant highly correlated errors. Nearly all papers investigating how well the CMB can do include some other observations or constraints to break that near degeneracy resulting in very much smaller errors. A good example of this near degeneracy is the correlation between Ω_M and Ω_Λ which points out the power of SN Ia observations and the difficulty the CMB has in determining Λ (Ω).

2. **Independent Check:** CMB observations are quite challenging technically, observationally, and in terms of understanding potential foregrounds. Scientifically one wants an independent check both of an individual experiment and of the whole technique. While MAP (140M$) is an impressive experiment, Planck (400M$) represents about an order of magnitude improvement. It is unlikely that there will be a repeat of Planck for a very long time. Even a repeat mission would not provide an independent check of technique.

3. There is a complementarity of CMB and SN Ia observations


SN Ia
CMB
Cosmic Complementarity
Vacuum Density Ω_Λ
Matter Density Ω_m
0
0.2
0.4
0.6
0.8
1
0
0.2
0.4
0.6
0.8
1

Weak Lensing Compared to CMB

Full-sky weak lensing survey compared with CMB satellites[a]

$\sigma(p_i)$	WL	MAP	Planck
$\sigma(\Omega_m h^2)$	0.024 (430)	0.029	0.0027
$\sigma(\Omega_b h^2)$	0.0092 (310)	0.0029	0.0002
$\sigma(m_\nu)$	0.29 (230)	0.77	0.25
$\sigma(\Omega_\Lambda)$	0.079 (180)	1.0	0.11
$\sigma(\Omega_K)$	0.096 (200)	0.29	0.030
$\sigma(n_S)$	0.066 (470)	0.1	0.009
$\sigma(\ln A)$	0.28 (310)	1.21	0.045
$\sigma(z_s)$	0.047 (56)	(1)	(1)
$\sigma(\tau)$	–	0.63	0.004
$\sigma(T/S)$	–	0.45	0.012
$\sigma(Y_p)$	(0.02)	(0.02)	0.01

[a] Note that the MAP numbers assume temperature information only whereas the Planck numbers assume additional polarization information so as to span the range of possible outcomes from the CMB missions. We also assume priors of $\sigma(Y_p) = 0.02$ and $\sigma(z_s) = 1$

SNAP's
Value, Timeliness, & Appropriateness

Cosmology is a ripe field – technically and theoretically and SNAP can play a key role. SNAP provides the best method to probe the dark energy.

Planck's cosmological promise is based upon theorist's predictions of an ideal experiment. Experimental reality is usually not as clean, beautiful, and expected. The Ω_M versus Ω_Λ plots made more than a couple of years ago, all centered the best fit on $\Omega_M = 1$ and $\Omega_\Lambda = 0$. The key issue for CMB experiments is a deep understanding and checking of systematic errors. An independent check is certainly warranted. SNAP can provide a high-value, very independent dataset.

SNAP's SN Ia approach is powerful and well developed. The CMB space missions were approved with much less understanding of either the foreground astrophysical signals or theoretical basis. They were and are being developed along the way to the full mission.

The SNAP team is a strong group well organized for the development of the mission.

The key pieces are in place for a successful mission!